CCR Number: 0033	CRITICALITY: ROUTINE	DUE:06/25/99

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NEW MILLENNIUM PROJECT CONFIGURATION CHANGE REQUEST

PROGRAM EO-1

CCR NO. 0033

DATE INITIATED 06/10/99

TITLE Baseline EO-1 TRW/GSFC INTERFACE DOCUMENT

ORIGINATOR D. Mandl/GSFC

ORIGINATOR'S CHG. NO.

SPONSOR/CODE D. Mandl **PHONE** x4323

EFFECTIVITY

ITEM: EO-1
S / N
ITEM:
S / N
ITEM:
S / N

CHANGE CLASS

	I	II
PRELIMINARY	☐	☐
FORMAL	☐	☐

TYPE OF CHANGE

MILESTONE	☐	INTERFACE	☐	SOFTWARE	☐
DOCUMENT	☒	POWER	☐	OTHER	☐
COST	☐	WEIGHT	☐		☐

DOCUMENTS OR SOFTWARE AFFECTED

EO-1TRW/GSFC ICD

PROBLEM

The attached draft version of EO-1 Project TRW/GSFC Data Interface Control Document requires baselining. This document describes the data interfaces between TRW and Goddard Space Flight Center (GSFC) to support Hyperion instrument checkout, Level 0 processing and Hyperion scene requests..

PROPOSED SOLUTION

Approve the attache draft version of EO-1 TRW/GSFC Data Interface Control Document by the EO-1 Level II Configuration Control Board (CCB). The signed CCR will officially approve the document by EO-1 Project Management. Future changes will be initiated by submittal of Configuration Change Requests (CCRs) and Requirements Change Notices. This document is maintained by EO-1 Configuration Management Office.

BOARD ACTION
APPROVE ☑
APPROVE WITH CHANGE ☐
DISAPPROVE ☐
WITHDRAW ☐

APPROVAL LEVEL REQUIRED
LEVEL I HQS ☐
LEVEL II GSFC ☒
LEVEL III ☐

CRITICALITY LEVEL
EMERGENCY ☐
URGENT ☐
ROUTINE ☒

PROCUREMENT CHANGE ORDER CLASSIFICATION
ROUTINE: OPTION 1 ☐ OPTION 2 ☐
URGENT: OPTION 1 ☐ OPTION 2 ☐
EMERGENCY ☐

COMMENTS

CHAIRPERSON [signature] DATE 9/10/99

3/28/96

EO-1 TRW-GSFC ICD
Draft Issue
June 4, 1999

EO-1
TRW-GSFC DATA
(ICD)

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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1. Introduction

This Interface Control Document (ICD) describes the data interfaces between TRW and Goddard Space Flight Center (GSFC) to support Hyperion instrument checkout, Level 0 processing, and Hyperion scene requests.

1.1 Scope

This ICD contains the interface requirements for data interfaces that support Hyperion data collection events (DCE), Level 0 processing of Hyperion science data, Hyperion checkout and anomaly resolution, and scene requests for Hyperion science data. The requirements defined include data content, data format, data access and transfer methods, and organizational responsibilities.

1.2 Applicability

This ICD applies to data supporting the verification, validation, and use of the Hyperion instrument flown on the EO-1 spacecraft.

1.3 Approval

This ICD will be approved and signed by authorized representatives of the TRW Hyperion Project Office, GSFC EO-1 Project Office, GSFC Mission Operations Center (MOC), and GSFC Science Validation Facility (SVF).

1.4 Applicable Documents

1. IF1-0228, Hyperion Interface Control Document, Rev. New, March 24, 1999
2. WARP File ID Assignment Definitions, Update May 25, 1999, private communication from Bruce Trout
3. National Center for Supercomputing Applications (NCSA) HDF Development Group, *HDF User's Guide v4.1r2* , July 21, 1998. URL:http://hdf.ncsa.uiuc.edu/doc.html
4. NCSA HDF Development Group, *HDF User's Reference Manual v4.1r2*, April 8, 1998. URL:http://hdf.ncsa.uiuc.edu/doc.html
5. NCSA HDF Development Group, *HDF Specification and Developer's Guide, Version 3.2*, September 1993. URL:http://hdf.ncsa.uiuc.edu/doc.html
6. EO-1 Space to Ground ICD, dated September 24, 1998
7. EO-1 Mission Operations Center (MOC) to Mission Science User Working Group (MSUWG) Interface Control Document, Version 3, April 6, 1999.
8. EO-1 ICD for Radiometric Calibration Processing & Performance Assessment Processing between NASA/GSFC and MIT/LL, Document 005, dated November 2, 1998.
9. EO-1 ICD for Atmospheric Corrector Level 0/1 Processing, draft Rev. A, dated April 30, 1999
10. Earth Orbserving-1 (EO-1) Memorandum of Understanding between Mission Operations Center (MOC) and Flight Dynamics Facility (FDF) Orbital and Mission Aids Transformation System (FORMATS), Revision 1, April 20, 1999

2. Overview of Data Processing

There are three types of data interfaces between TRW and GSFC: science data (Sn), engineering data (state-of-health and housekeeping data) (En), and planning data (Pn). These interfaces have different characteristics during the different mission phases, launch and early orbit testing, and science validation, as the roles of the organizations evolve. This section presents an overview of the roles of TRW and GSFC in supporting these interfaces, describes the nature of the data transmitted, presents data flows for each interface type and project phase, and describes the supporting physical connectivity.

2.1 Glossary of Terms

This section defines key terms used throughout the document.

2.1.1 Program Phases

Interfaces in this document are described for two program phases:

Early Orbit Checkout. This phase represents the first 60 days on orbit during which the spacecraft and instruments are checked out and instrument performance validated. During this phase, TRW plays the lead role in monitoring instrument health and safety, and requesting scenes for calibration and imaging to support performance validation.

Science Validation. This phase represents the normal operations phase following instrument checkout and validation. During this phase, TRW plays a support role for instrument anomaly analysis, and requests scenes as needed to support routine state-of-health and image monitoring, and calibrations needed for Level l processing. In the event an instrument anomaly occurs, the GSFC Flight Operations Team (FOT) will gather appropriate diagnostic data using operations procedures provided by TRW, notify TRW of the contingency, and make the collected data available to assist the analysis.

2.1.2 Data Types

The major data types in each category are described below.

2.1.2.1 Science data.

Science data consists of Level 0 and Level 1 data products. Level 0 data contains the raw pixel data re-ordered as the focal planes collected the data, with SWIR and VNIR data frames combined. Level 1 data products contain supporting metadata, ancillary data, and a log file that includes information about the Level 1 processing, including calibration data.

Data Collection Event (DCE). A data collection event is defined as any collection of data taken between instrument activation and de-activation (return to idle mode). A DCE may be defined for imaging, solar calibration, lunar calibration, or vicarious (ground) calibration, and includes the dark and white internal calibration collections taken along with the external image. DCE data is recorded onboard the spacecraft on the Wideband Advanced Recorder Processor (WARP); a single DCE will consist of multiple WARP files.

Earth Image Data. Earth radiance data collected for science and instrument performance assessments. (This data can be used for vicarious calibration.)

Ancillary data. Ancillary data is supporting data derived from the downlink of the spacecraft during the image collection. It consists of selected spacecraft and instrument state-of-health telemetry that provides information about the on-orbit environment at the time of the DCE.

Calibration data. Calibration data provides information on the instrument response to dark images (dark cal) and white images (lamp cal). External calibrations (solar, lunar, ground/vicarious) provide additional information on spectral and spatial characteristics of the instrument.

Metadata. "Data about data" – Metadata provides information to support higher levels of processing and comes from sources other than data downlinked by the spacecraft or instruments. Some of the data is unchanging, such as pre-flight characterization data, and other data, such as quality assurance information, changes for each image.

2.1.2.2 State-of-Health/Housekeeping Data

State-of-health/housekeeping (SOH/HK) data is collected onboard the spacecraft continuously, and redundantly recorded on the WARP during a DCE. The following data types are associated with SOH/HK data:

Trending data. Trending data refers to selected telemetry mnemonics, specified by each instrument team and the spacecraft team, which are trended by the GSFC Mission Operations Center (MOC) over a 24-hour period. The trended parameters are extracted from the logged SOH/HK received over the S-band downlink.

SOH directory. SOH recorded for the life of the mission is labeled with the pass time of the data dump in a directory maintained at the Front End Data System (FEDS) of the MOC. This directory allows retrieval of the data by time and can be accessed 24 hours/day.

WARP DCE SOH. This category of SOH/HK is recorded on the WARP and is redundant to the Command and Data Handling (C&DH) S-band SOH/HK recorder. It is also referred to as ancillary data, and is defined in Section 2.1.2.1 above.

Flight Dynamics Products. These products are produced at the MOC from orbital and attitude data downlinked in the SOH data.

2.1.2.3 Planning Data

The data types that support planning are described below.

Scene requests. Scene requests define the desired Hyperion collection, either an imaging or calibration event, in terms of time, location, duration, and required spacecraft pointing.

DCE Catalog. A catalog, created and maintained at the Science Validation Facility (SVF), provides information on scheduled DCEs, their collection status, and the quality of any completed collections. This catalog is accessible 24-hours per day.

Scene quality assurance. This data type provides an assessment of the quality of the image received during a collection event, and is used to determine if collected scenes need to be rescheduled.

2.2 Interface Summary

We have defined unique interfaces between TRW and GSFC to exchange data in support of the three interface categories, and distinguish between similar data in different phases if a different transmission method is used or if the access or transfer frequency changes. The paragraphs below provide an overview of the functional interfaces in each category. In the figures presented in these sections, these interfaces are numbered. Table 2-1 summarizes the major characteristics of the interfaces. Sections 3 through 5 describe them in detail.

Table 2-1 Interface Summary

I/F ID	EO C/O	Nom Ops	Interface	Parties	Frequency of Occurrence	Items to be Transmitted
S1	X	X	Hyperion L0 processing algorithm	TRW to MOC/DPS	Once	Hyperion L0 software
S2	X		Electronic transfer of Hyperion L0 data, via dedicated fractional T-1	MOC/DPS to TRW	Each DCE	Hyperion L0 data sets, small scenes $\leq$125 MB
S3	X	X	Tape or electronic transfer, via Ftp from drop site, of L0 data	MOC/DPS to TRW	Tape once/day, 3 day delay (checkout); twice/week, 3 working day delay (nominal ops) Electronic upon special request	AC, ALI and Hyperion L0 data sets; large Hyperion data sets (>125 MB)
S4			Reserved			
S5	X	X	Transfer of AC and ALI L1 data	SVF to TRW	Upon request	Requested AC and ALI L1 data sets
S6	X	X	Metadata	MSO/SVF to TRW	Twice/week	Existence of validation and calibration site characterization data
E1	X	X	Telemetry parameter trending from playback and real-time data	MOC/CGS to TRW	Once per day (checkout) Upon request electronically (nominal ops)	Trended selected Hyperion telemetry parameters, as available, from logged data
E2	X	X	Logged S-band raw SOH; SOH directory	MOC/DHDS to TRW	Upon request electronically via ASIST access	Hyperion and spacecraft SOH data; Event log
E3	X		Real-time SOH	MOC/DHDS to TRW	During checkout, upon request via ASIST	Real-time Hyperion SOH data

E4	X		Electronic transfer of DCE SOH (ancillary data)	MOC/DPS to TRW	Upon request via pull from Ftp site	Selected DCE SOH parameters in engineering units
E5	X	X	Tape or electronic transfer of DCE SOH (ancillary data)	MOC/DPS to TRW	Tape once/day, 3 day delay (checkout); twice/week, 3 working day delay (nominal ops) Electronic upon special request	Selected DCE SOH parameters in engineering units
E6	X	X	Flight dynamics products	MOC/FDSS to TRW	Three to four times per week	Predicted EO-1 ephemeris; see Section 4.3
P1	X		Scene or calibration request	TRW to EO-1 Project Checkout Team/MSO	Upgrades of nominal plan once/week	Target, acquisition time, instrument parameters
P2		X	Calibration request	TRW to EO-1 MSO	Once per week	Calibration requirements, instrument parameters
P3	X		DCE schedule and status	EO-1 Project Checkout Team/MSO to TRW	Once per day	DCEs scheduled; status of acquisition
P4		X	DCE schedule and status; scene metadata; DCE catalog	EO-1 MSO to TRW	Accessible 24 hours per day	DCEs scheduled; status of acquisition; paired L7 scene; AC and ALI images
P5		X	Scene quality assurance	TRW to EO-1 MSO	Twice per week	Scene quality
P6		X	Long term plan inputs	Coordinating Committee	Once	Plan for Hyperion

The data received from the spacecraft is formatted into Virtual Channels (VCs); different VCs are carried in each of the input “bubbles” to the left of the figures in Sections 2.3 – 2.5 below. Table 2-2 summarizes these VCs and their downlink source.

Table 2-2 Virtual Channel Definitions

VC #	Definition	Downlink Source
VC0	Real-time spacecraft housekeeping	S-band , real-time SOH
VC1	Playback spacecraft housekeeping	S-band, C&DH recorder
VC2	Playback spacecraft events	S-band, event log
VC3	SOH recorded on WARP	X-band or S-band, WARP
VC4	Playback GPS B packet	S-band, C&DH recorder
VC6	Hyperion SWIR focal plane data	X-band or S-band, WARP
VC7	Hyperion VNIR focal plane data	X-band or S-band, WARP
VC8	ALI/MS PAN instrument data	X-band or S-band, WARP
VC9	LEISA/AC instrument data	X-band or S-band, WARP
VC11	Retransmit of VC1	S-band, C&DH recorder
VC12	Retransmit of VC2	S-band, C&DH recorder
VC14	Retransmit of VC4	S-band, C&DH recorder

2.3 Science Data Flow

Science data flow begins with instrument data collection with on-board storage of the data on the Wideband Advanced Recorder Processor (WARP), downlink of the science data via S-band or X-band to a ground station, and, finally, transfer of the downlinked data to the Mission Operations Center (MOC). At the MOC, the Hyperion data is processed to Level 0, using an algorithm provided by TRW to restore the correct pixel order, and forwarded either electronically or via tape to TRW.

During the launch and early orbit checkout phase, small scenes, perhaps no larger than a cube (about 3 seconds of data collection) are downlinked via S-band and forwarded electronically from the ground station to the MOC. The size of the scenes that can be downlinked via S-band during a single contact is determined by the available back-up S-band downlink capacity. This limitation is defined in Reference 6. Figure 2-1 shows the Hyperion data interfaces for the early orbit testing phase. During this program phase, the Hyperion Level 0 data sets are sent electronically (S2) to expedite instrument validation. AC and ALI data sets are transferred via tape (S3). The data downlinked from each source on the left of the diagram is summarized in Table 2-2.

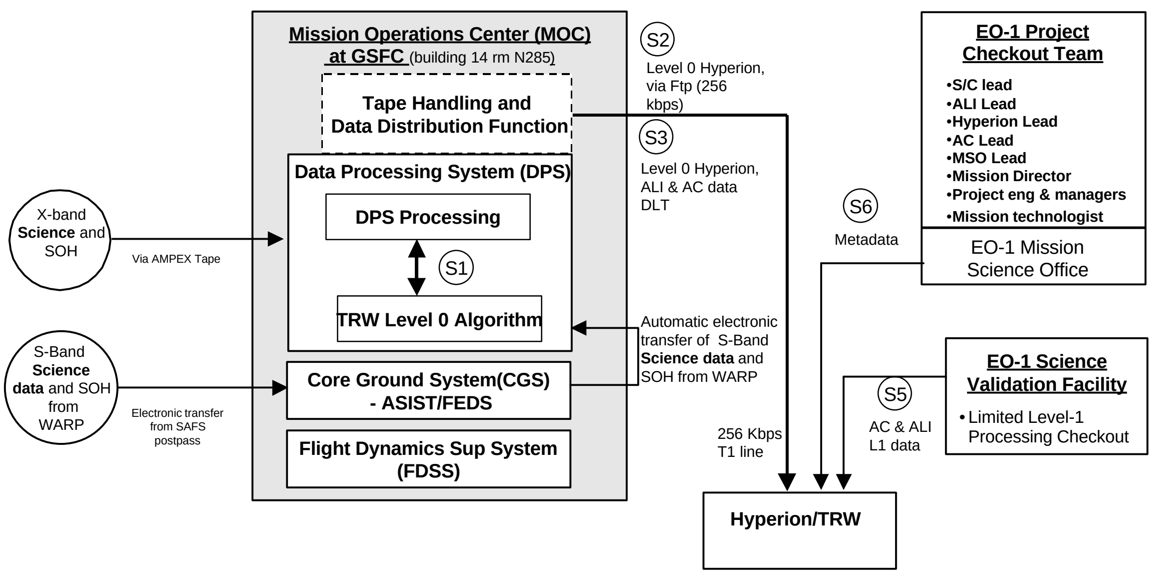

Figure 2-1 Science Data Flow for Early Orbit Testing Phase

During the science validation phase, images collected are downlinked via X-band, and forwarded via tape from the ground stations to the MOC. Figure 2-2 illustrates the data flow interfaces for the Science Validation phase. The dedicated T-1 line is reduced to 56 Kbps during this phase, and all Level 0 is transferred via tape from the MOC to TRW (S3). TRW receives Level 1 AC and ALI data sets from the SVF (S5). Flight dynamics products (E6, see Section 2.4), scheduled DCEs and their status (P4, see Section 2.5), and existence of ground characterization data (S6) are incorporated into metadata.

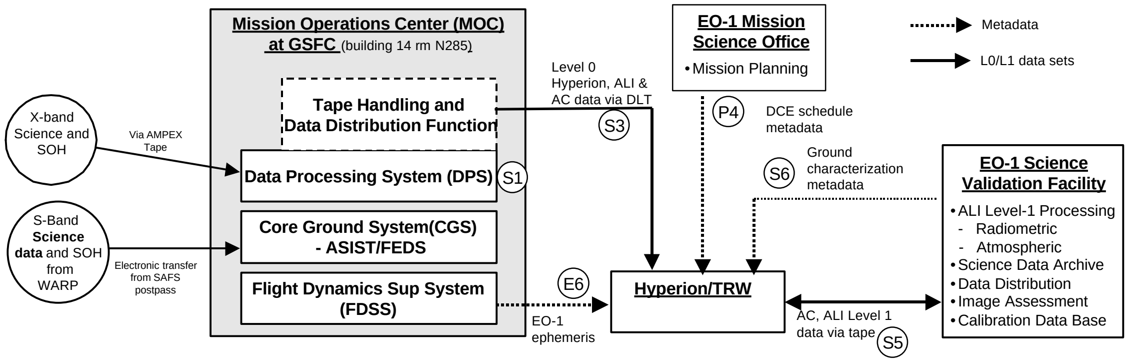

Figure 2-2 Science Data Flow for Science Validation Phase

2.4 State-of-Health and Housekeeping Data Flow

State-of-health (SOH) and housekeeping (HK) data are continuously collected and recorded onboard the EO-1 spacecraft. Any critical events that occur are recorded in a separate event log. During a contact, the recorded SOH/HK data and event log are downlinked on the S-band link along with any telemetry that is being collected in real-time during the contact. DCE SOH, collected on the WARP, is downlinked via X-band. The receiving ground station forwards the data to the MOC, where it is processed in the Core Ground System (CGS) or Data Processing System (DPS) and made available to TRW. The data downlinked from each source on the left of the diagram is summarized in Table 2-2.

Selected parameters from the full 24-hour set of recorded SOH data are processed to engineering units, trended at the CGS, and sent as sequential print files (E1). All recorded (E2) or real-time (E3) instrument and spacecraft telemetry is available in raw form via TRW ASIST workstation access to the Front End Data System (FEDS). SOH data collected on-board the WARP during the DCE (E4) are processed once per DCE into a SOH Level 0 data set. This ancillary data set is available electronically over the dedicated T-1 line to TRW via “pull” from an Ftp site. In addition, the Flight Dynamics Support Subsystem develops a set of flight dynamics products (E6), which are made available to TRW to support scene selection. Figure 2-3 illustrates these interfaces.

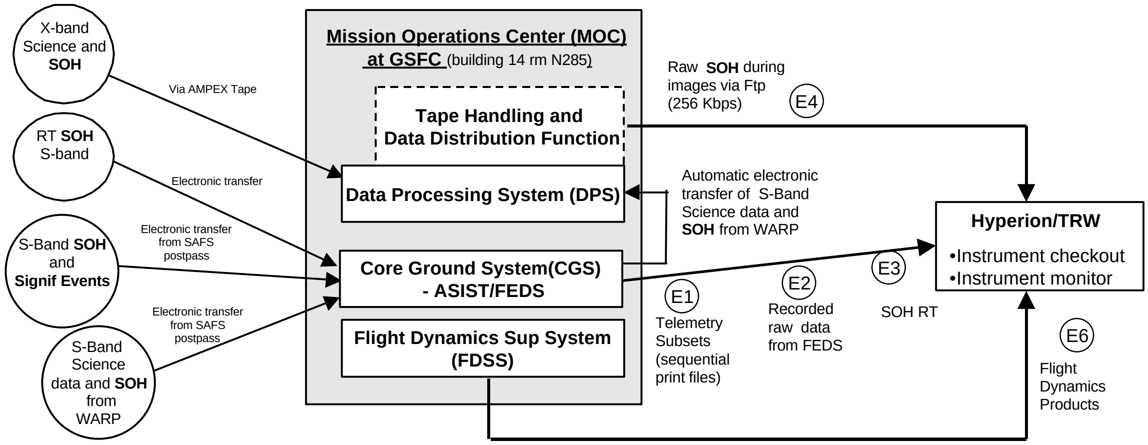

Figure 2-3 SOH/HK Data Flow for Early Orbit Testing

These interfaces are virtually the same during the science validation phase, as illustrated in Figure 2-4 below. DCE SOH will not be transferred electronically during this phase, but will be sent with the Level 0 data sets on tape (E5). The format of this tape is documented in Reference 7, Appendix A. TRW does not access the RT SOH during this phase.

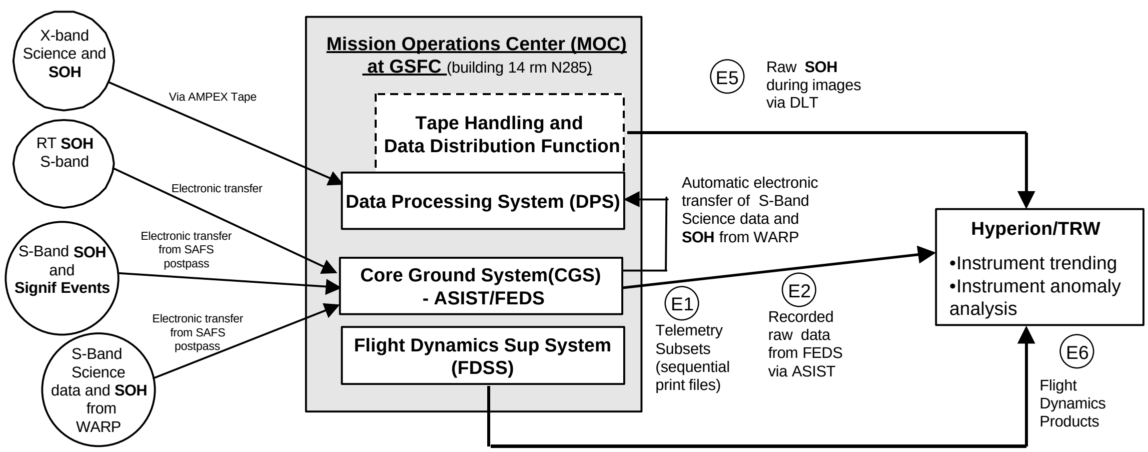

Figure 2-4 SOH/HK Data Flow during Science Validation Phase

2.5 Planning Flow

During launch and early orbit testing, the Hyperion team makes scene requests for ground calibrations, images, or external calibrations. These requests (P1) originate at the TRW facility, and go to the EO-1 project team, where a consolidated list of events is adjudicated. The final list of scheduled events and the status of DCEs scheduled are made available to TRW by the EO-1 Project Team (P3). Figure 2-5 illustrates these interfaces.

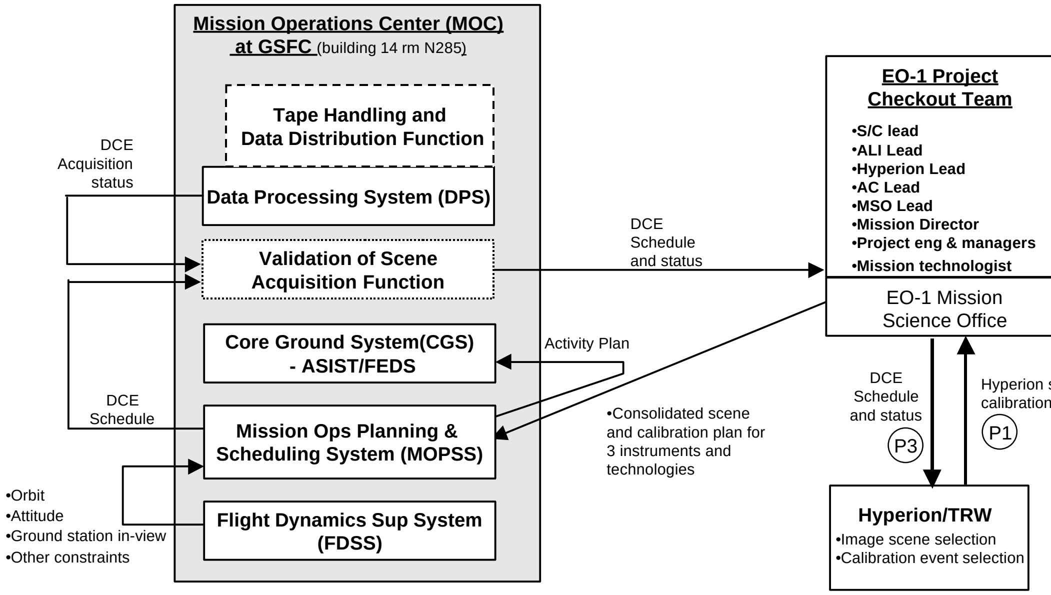

Figure 2-5 Planning Flow for Early Orbit Testing

During the Science Validation phase, TRW engineers perform performance monitoring of the instrument and develop calibration requests and updated scene requests (P2). TRW also provides inputs to the Long Term Plan (LTP) for Hyperion (P6). The DCE schedule and status (P4) are made available to TRW. TRW provides a metric of scene quality (P5) to the EO-1 Mission Science Office to support any required re-scheduling of scenes. Figure 2-6 illustrates the planning interfaces for this phase.

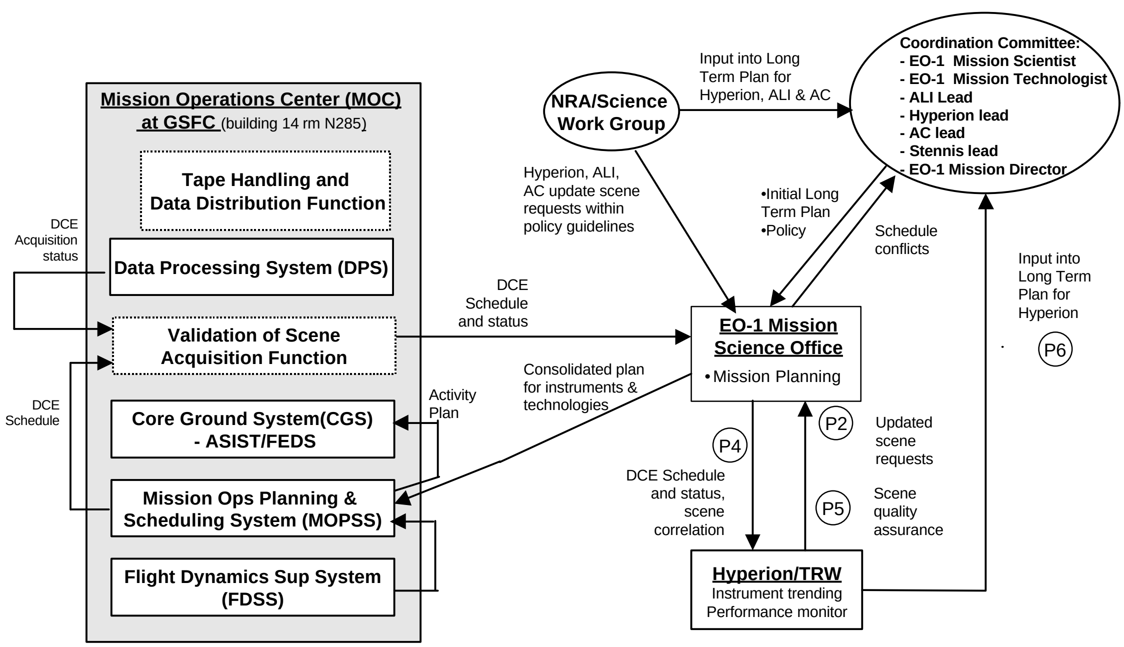

Figure 2-6 Planning Data Flow for Science Validation Phase

2.6 Physical Connectivity

The data for these interfaces are carried over three different types of physical interfaces: electronically over a dedicated circuit carried between TRW and GSFC by the NISN network; electronically over the Internet; and via tape. Figure 2-7 below presents a diagram of the dedicated link connectivity between TRW and NASA, and illustrates how the TRW network is firewalled from the closed NASA network.

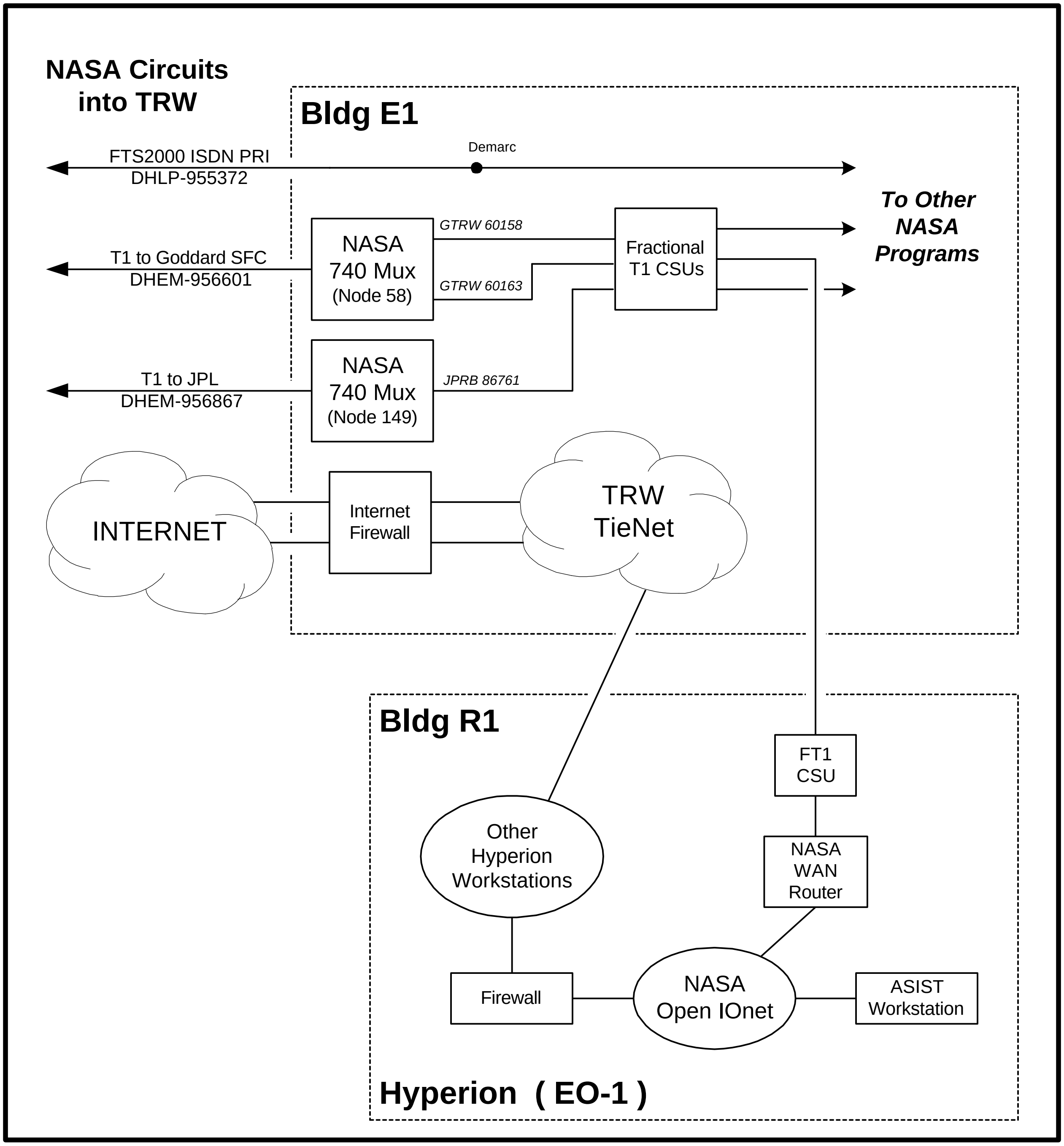

Figure 2-7 TRW - NASA Links

3. Science Data Interfaces

3.1 Level 0 Processing Algorithm

This section provides the interface requirements for the MOC DPS software to the TRW software algorithm that is integrated into the DPS to de-scramble the Hyperion focal plane data. This interface is indicated as S1 on the diagrams above. The readout pattern and data format are presented below.

3.1.1 Readout pattern for the VNIR focal plane

Figure 3-1 illustrates the format of the VNIR focal plane with 70 spectral and 256 spatial pixels read out. The order of the read is one pixel from quadrant 1, followed by one pixel from quadrant 2, then quadrant 3, then quadrant 4, returning to quadrant 1. Pixels are read from the outside to the inside in the spatial direction.

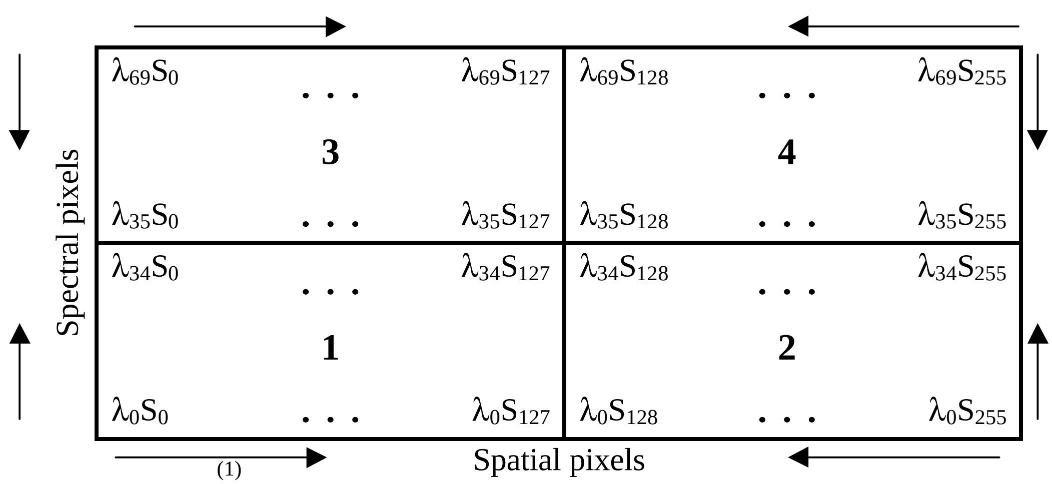

Figure 3-1 VNIR Focal Plane Readout Pattern

The data format for the VNIR is given in Reference 1 as shown in Table 3-1.

Table 3-1 Hyperion VNIR Data Format

<table>
<tr><th rowspan="2">Count N</th><th colspan="8">Hyperion VNIR Data Format</th></tr>
<tr><th colspan="2">MSB DB(31:24)</th><th>DB(23:18)</th><th colspan="3">DB(15:8)</th><th colspan="2">DB(7:0) LSB</th></tr>
<tr><td>1</td><td colspan="2">VNIR Header ID</td><td>TC8</td><td colspan="3">TC7</td><td colspan="2">TC6</td></tr>
<tr><td>2</td><td colspan="2">VNIR Header ID</td><td>TC5</td><td colspan="3">TC4</td><td colspan="2">TC3</td></tr>
<tr><td>3</td><td colspan="2">VNIR Header ID</td><td>XX</td><td>OSD</td><td colspan="2">OSC</td><td>OSB</td><td>OSA</td></tr>
<tr><td>4</td><td colspan="2">VNIR Header ID</td><td>Sync Time</td><td colspan="5">Frame #</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td></td><td>DB(31:28)</td><td colspan="2">MSB DB(27:16) LSB</td><td colspan="2">DB(15:12)</td><td colspan="3">MSB DB(11:0) LSB</td></tr>
<tr><td>5</td><td>VNIR ID</td><td colspan="2">VNIR Data Word 1</td><td colspan="2">VNIR ID</td><td colspan="3">VNIR Data Word 2</td></tr>
<tr><td>6</td><td>VNIR ID</td><td colspan="2">VNIR Data Word 3</td><td colspan="2">VNIR ID</td><td colspan="3">VNIR Data Word 4</td></tr>
<tr><td>-----</td><td>-----</td><td colspan="2">-----</td><td colspan="2">-----</td><td colspan="3">-----</td></tr>
<tr><td>-----</td><td>-----</td><td colspan="2">-----</td><td colspan="2">-----</td><td colspan="3">-----</td></tr>
<tr><td>8963</td><td>VNIR ID</td><td colspan="2">VNIR Data Word 17917</td><td colspan="2">VNIR ID</td><td colspan="3">VNIR Data Word 17918</td></tr>
<tr><td>8964</td><td>VNIR ID</td><td colspan="2">VNIR Data Word 17919</td><td colspan="2">VNIR ID</td><td colspan="3">VNIR Data Word 17920</td></tr>
</table>

Note. “VNIR Header ID” is “FE” and “VNIR ID” is "1".

Assuming that all spatial pixels for a single wavelength are read out in each quadrant first, the contents of the data fields will be as shown in Table 3-2.

Table 3-2 VNIR Data Field Content

	DB(31:28)	MSB DB(27:16) LSB	DB(15:12)	MSB DB(11:0) LSB
5	VNIR ID	$\lambda_0 S_0$	VNIR ID	$\lambda_0 S_{255}$
6	VNIR ID	$\lambda_{69} S_0$	VNIR ID	$\lambda_{69} S_{255}$
7	VNIR ID	$\lambda_0 S_1$	VNIR ID	$\lambda_0 S_{254}$
8	VNIR ID	$\lambda_{69} S_1$	VNIR ID	$\lambda_{69} S_{255}$
-----	-----	-----	-----	-----
-----	-----	-----	-----	-----
8963	VNIR ID	$\lambda_{34} S_{127}$	VNIR ID	$\lambda_{34} S_{128}$
8964	VNIR ID	$\lambda_{35} S_{127}$	VNIR ID	$\lambda_{35} S_{128}$

3.1.2 Readout Pattern for the SWIR Focal Plane

The SWIR focal plane has four readout ports, which read out adjacent pixels in 2x2 arrays, as illustrated in Figure 3-2. 172 spectral and 256 spatial pixels are read out. Two 12-bit buses read the data, with Bus A multiplexing ports 1 and 2 (along the even spatial band), and Bus B multiplexing ports 3 and 4 (along the odd spatial band). In the ordering of the data to the WARP interface, a word from bus A is followed by a word from bus B, so that one pixel is read out from port 1, followed by port 3 (see (1) in the figure below), then port 2, and finally port 4 (see (2) in the figure below). This group of four pixels is followed by the next 2x2 array in the spectral direction (see (3) below) until all wavelengths have been read. The pattern is then repeated for the next set of quadrants in the spatial direction (see (4) below).

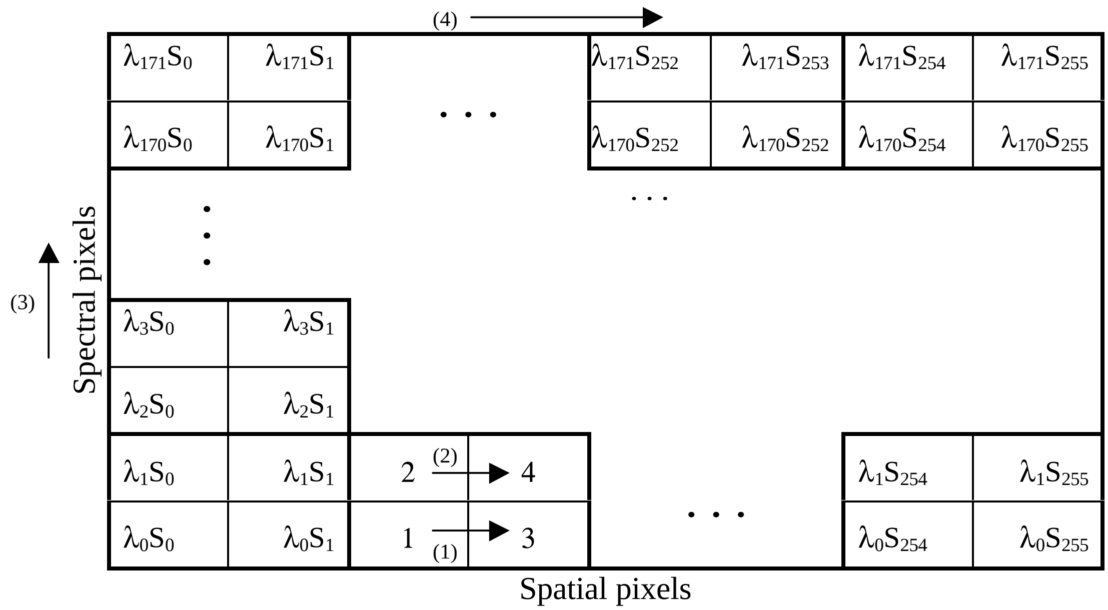

Figure 3-2 SWIR Focal Plane Readout Pattern

The data format for the SWIR is given in Reference 1 as shown in Table 3-3.

Table 3-3 Hyperion SWIR Data Format

Count N	Hyperion SWIR Data Format						
	MSB DB(31:24)	**DB(23:18)**				**DB(15:8)**	**DB(7:0) LSB**
1	SWIR Header ID	TC8				TC7	TC6
2	SWIR Header ID	TC5				TC4	TC3
3	SWIR Header ID	INT Time				OSD	OSC
4	SWIR Header ID	GD	GC	GB	GA	OSB	OSA
5	SWIR Header ID	Sync Time				Frame #	

	DB(31:28)	**MSB DB(27:16) LSB**	**DB(15:12)**	**MSB DB(11:0) LSB**
6	SWIR ID	SWIR Data Word 1	SWIR ID	SWIR Data Word 2
7	SWIR ID	SWIR Data Word 3	SWIR ID	SWIR Data Word 4
-----	-----	-----	-----	-----
-----	-----	-----	-----	-----
22020	SWIR ID	SWIR Data Word 44029	SWIR ID	SWIR Data Word 44030
22021	SWIR ID	SWIR Data Word 44031	SWIR ID	SWIR Data Word 44032

Note. “SWIR Header ID” is “FA” and “SWIR ID” is "2".

Assuming that the 2x2 arrays are read out in the spectral direction, the contents of the data fields will be as shown in Table 3-4.

Table 3-4 SWIR Data Field Content

	DB(31:28)	MSB DB(27:16) LSB	DB(15:12)	MSB DB(11:0) LSB
6	SWIR ID	$\lambda_0 S_0$	SWIR ID	$\lambda_0 S_1$
7	SWIR ID	$\lambda_1 S_0$	SWIR ID	$\lambda_1 S_1$
8	SWIR ID	$\lambda_2 S_0$	SWIR ID	$\lambda_2 S_1$
9	SWIR ID	$\lambda_3 S_0$	SWIR ID	$\lambda_3 S_1$
-----	-----	-----	-----	-----
-----	-----	-----	-----	-----
22020	SWIR ID	$\lambda_{170} S_{254}$	SWIR ID	$\lambda_{170} S_{255}$
22021	SWIR ID	$\lambda_{171} S_{254}$	SWIR ID	$\lambda_{171} S_{255}$

3.1.3 Overview of Hyperion Level 0 Processing

Level 0 processing of EO-1 Hyperion science data refers to the following set of tasks:

(1) Perform Reed-Solomon decoding on downlinked science data;
(2) Extract the science data from the VC-6 and VC-7 (see Table 2-2) data bitstreams, including removal of fill data;
(3) Flag corrupted data;
(4) Separate the data into files along “data type” boundaries (ground image, lunar cal, etc.), DCE image number boundaries, and “data stream” boundaries (pre-image dark cal, lamp cal, etc.).
(5) Perform various sanity checks to verify data integrity and instrument performance;
(6) Perform pixel re-ordering to de-scramble the readout from the VNIR or SWIR focal plane array;
(7) Reverse the order of the spectral indices;
(8) Concatenate the VNIR and SWIR science data together;
(9) Send the science data into a formatted output file (HDF format).
(10) Append “HDF attributes” to the output file. These attributes, which are described below in detail, list various properties about the data.

The data in this output file is referred to as Hyperion “Level 0 data.”

During on-orbit flight operations, NASA’s Goddard Space Flight Center (GSFC) will perform all ten of these tasks in order to produce the Hyperion Level 0 data files. Responsibility is divided between GSFC and TRW for writing the software needed to perform these ten tasks. Figure 3-3 illustrates this division. The text below details the division of responsibility.

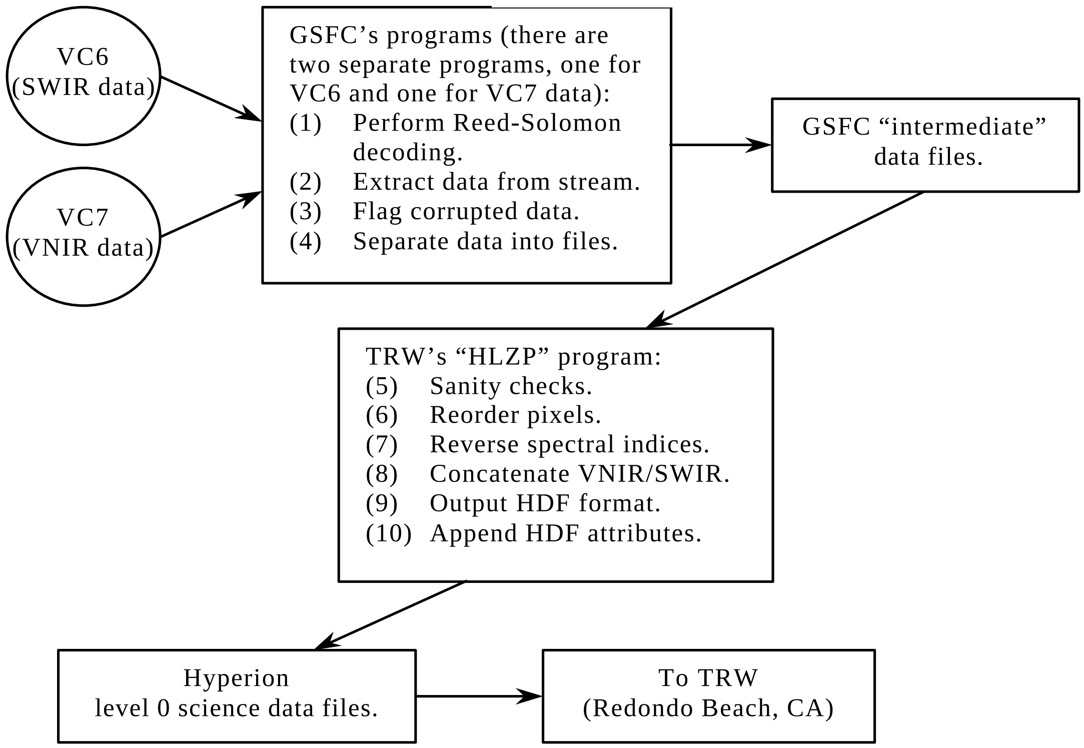

Figure 3-3 Hyperion Level 0 Processing of Science Data

As illustrated in Figure 3-3, the ten steps needed to produce the Hyperion Level 0 data files are performed by two different software programs, one written by GSFC and the other written by TRW. GSFC is writing the software code to perform the first four steps, (1) through (4). TRW is writing the software code to perform the next six steps, (5) through (10).

The two software programs (GSFC's program and TRW's program) are separate, standalone programs that are not "linked" in any way. Each intermediate file that is output by GSFC's program (and then input by TRW's program) is referred to as an "intermediate" file, appropriately enough.

TRW's program is named the HLZP (Hyperion Level Zero Processor).

3.1.4 Tasks Performed by TRW's HLZP Software

TRW's HLZP program is normally run with the following syntax:

hlzp –s EO12000103A011.1 –v EO12000103A012.1

The input files are specified with the "-s" flag (the SWIR "intermediate" file produced by GSFC's software) and the "-v" flag (the corresponding VNIR "intermediate" file). (The

HLZP can actually be called with just one input file instead of two, in which case the output file will be correspondingly smaller.)

TRW's HLZP program will read in the two Hyperion science data files (VNIR and SWIR) generated by GSFC's Level 0 processing software, and perform the following tasks on each file:

5) Perform various sanity checks. If any of these checks fails, then the program terminates with a descriptive error message:
   a) Confirm that the host processor uses variables that are the same size as what the HLZP program expects: sizeof(char)=1 byte, sizeof(u_char)=1 byte, and sizeof(u_short)=2 bytes.
   b) Confirm that the frame numbers (which are listed in the science data frame headers) are all sequential (i.e., frame numbers are not skipped).
   c) Confirm that the upper 4 bits of each 2-byte pixel (VNIR or SWIR) contain the proper instrument ID bit sequence. If the upper 4 bits of a pixel contain a “missing data” flag (bit sequence = 0x3), the HLZP will issue an error message and terminate immediately. (If the –r “report only” command line flag is used, then the HLZP program will, instead of terminating, read the entire file and report the number of pixels marked with the “missing data” flag.)
   d) Confirm that instrument settings do not change during the course of a file. (The instrument settings are recorded in the science data headers). Instrument settings include the offset settings (VNIR and SWIR), the gain settings (SWIR only) and the integration time setting (SWIR only).
   e) Confirm that the "sync time," as recorded in the science data header, changes once every second.
   f) Confirm that the "time code," as recorded in the science data header, changes every time the "sync time" changes, but one frame later.
6) Remap the pixels to descramble the readout from the VNIR or SWIR focal plane array. (An optional command line flag, -o, can be used to skip this step when processing artificial test data that does not need to be descrambled.)
7) Reverse the order of the spectral indices. This means that band[0] now corresponds to the shortest wavelength.

After these three tasks are performed on each of the two input files, the following three tasks are performed:

8) Concatenate together the VNIR data and SWIR data. Before this concatenation is performed, checks are done to confirm that the VNIR and SWIR files pair-up properly. The VNIR and SWIR filenames are parsed to confirm that:
   a) the two filenames have the same year and day stamp;
   b) the two files represent the same DCE image number;
   c) the two files represent the same event type (i.e., ground image, solar cal, deep space cal, internal cal, or lunar cal);
   d) the two files represent the same data type (i.e., pre-image dark cal, image, post-image dark cal, or lamp cal);

e) the file specified with"-v" is indeed labeled as a VNIR file, and the file specified with "-s" is indeed labeled as a SWIR file. In addition, a check is done to confirm that the 'sync time' field located in the VNIR header always changes within one frame of any changes in the 'sync time' field located in the SWIR header.

9) Write the output data to a file in HDF format. (This is the "Level 0" data file.)
10) Append "HDF attributes" to the output file. (A full list/description of the HDF attributes is included below.)

During these six steps that the HLZP performs (numbers (5) thru (10)), if any errors are encountered, a message is written to both the monitor (stderr) and to a log file. The error log file will be named "hlzp_errorlog.txt," unless the user overrides this default filename with the -l command line flag. To assist with the diagnosis of any errors, the HLZP program has a "report-only" option (-r) which summarizes various characteristics of the input data file without generating any output file.

A property of computers is the order in which it stores bytes for two-byte variables, such as the Hyperion pixel data. The terms "little-endian" and "big-endian" are used to identify this processor characteristic. The HLZP program will run on a little-endian machine at GSFC (DEC Alpha 4000). However, the HLZP will be built to work on big-endian machines as well, since some of the pre-shipment testing at TRW will involve big-endian machines. The HLZP is built in such a way that the compilation procedure is the same regardless of whether the code is being compiled on a little or a big-endian machine - no files have to be modified and no special compiler flags, makefile flags, or environment variables are needed.

TRW has no way of testing the software on a DEC Alpha, so final testing will have to wait until after delivery to GSFC.

3.1.5 HLZP Input File

The input files for the TRW HLZP are the "intermediate" files generated by GSFC's portion of the Level 0 software. The format of the input filename will be:

Input filename: EO1yyyydddxxxx.1

where **yyyyddd** is the UTC date of the start of a DCE, with **ddd** being the day of the year. (Jan. 1 is day 001.) **xxxx** is the hex representation of the 2 byte file ID assigned to this data collection (see Reference 2). Each input file will contain either VNIR data or SWIR data, but not both. Each input file will have data from only one DCE. Each input file will contain data of only one event type (ground image, solar cal, deep space cal, internal cal, or lunar cal). Also, each input file will contain data of only one data type (pre-image dark cal, image, post-image dark cal, or lamp cal).

The data in the input file is organized into frames. Each frame has a header, the format of which is described in Reference 1. The header bytes appear in the input file in the order they appear in this reference. Thus, the first byte in the input file should be the instrument ID byte. The "frame number" field in the header is stored in big endian format. The "VNIR OSA" field and the "VNIR OSC" field in the header occupy the 4 lsb's of the byte boundaries shown in the reference. The "SWIR GA" field in the header occupies the 2 lsb's of the byte shown in the reference.

Following each header in the input file comes a frame of pixel data. VNIR frames each contain 256*70 pixels, and SWIR frames each contain 256*172 pixels. Each pixel is 2 bytes long. Only the 12 lsb's are actually used. The pixel data are stored in big-endian format in the input file. (The output file will likewise store the pixel data in big-endian format, regardless of the endian-ness of the host processor.) The pixels appear in the input file in the order they were read off of the focal plane array. The order in which the pixels were read off the focal plane array is assumed to be consistent with that described in Appendix A. Each frame of pixels in the input file is assumed to be stored in row-major order, where the spatial axis is the horizontal axis and the spectral axis is the vertical axis.

(NB: The HLZP program allows for the possibility that some "garbage" data might exist at the beginning and/or end of the input file. Legitimate data is parsed out from the garbage data by looking for science headers with the proper ID bytes. During normal operations, no garbage data will exist in the HLZP input files, since GSFC will have already removed any such garbage data. But during pre-delivery testing of Hyperion, such garbage data might appear. Hence, the HLZP program is built to be alert for the possibility of garbage data at the beginning and/or end of the input file(s). A warning message is printed to the monitor and to the log file if any such garbage data is encountered.)

3.1.6 HLZP Output File

The output from the HLZP is a file in Hierarchical Data Format (HDF) with Band Interleaved by Line (BIL) format. The hyperspectral cube data is stored in an SDS array ("Scientific Data Set") within HDF. The SDS array has three dimensions, which are in the following order. When HDF's C language routines are used to access the HDF file, the "start" array (see the HDF manual entry for SDwritedata) is indexed such that start[0] corresponds to the line number, start[1] corresponds to the band number, and start[2] corresponds to the sample number. The pixels are stored in big-endian byte order.

The HDF format allows a name to be given to the SDS array that holds the Hyperion science data. The array is named "Hyperion L0".

Various HDF attributes are also included in the output file. These attributes, which are listed in the next section, include SDS attributes only. (No "file attributes" are used.) The SDS attributes are all self-explanatory, except for "Sync Time" and "Time Code", which require some explanation. Once every second (about once every 225 frames), the "Sync Time" and the "Time Code" fields in the science headers change. The information about these changes is stored in the "Sync Time" and "Time Code" arrays. These are 1D arrays, which really represent 2D arrays strung out to one dimension, one row at a time.

There is one row in the 2D array for each range of frames over which "Sync Time" or "Time Code" is constant. For the case of "Sync Time", the first column is the starting frame number, the second column is the ending frame number, and the third column is the value stored in the "Sync Time" field in the header. "Time Code" is exactly the same, except six fields instead of one are needed to store the Time Code. Note that since "Sync Time" and "Time Code" do not change simultaneously, the number of rows in each array may be different.

The output filename is in this format:

EO1yyyyddd_vvvvssss_r1.L0

The yyyyddd date is the UTC date of the beginning of the DCE collection. ddd is the day of year (Jan. 1 = day 001). vvvv and ssss are the hex representations of the two-byte VNIR and SWIR file IDs that identify the instrument, the image number, the event type, and the data type. "r1" indicates this is the first run of this data set through the data processing software; every time the HLZP is re-run on a set of data, the user should increase the run number by one, using the "-e" flag.

3.1.6.1 HDF Attributes for Level 0 Data File

File Attributes:

<None>

SDS Attributes for Hyperion Level 0 Data:

Name	Max. Length	HDF Type	Example Value
L0 File Generated By	256	DFNT_CHAR8	"HLZP version 1.0.0"
File Byte Order	256	DFNT_CHAR8	"Big endian"
Time of L0 File Generation (UTC)	14	DFNT_CHAR8	"yyyydddhhmmss"
Frame Number Range	2	DFNT_UINT32	0,659
Number of Cross Track Pixels	1	DFNT_INT16	256
Number of Along Track Pixels	1	DFNT_INT32	660
Number of Bands	1	DFNT_INT32	70
Interleave Format	4	DFNT_CHAR8	"BIL"
Number of Pixels with Missing Data Flag	1	DFNT_UINT32	0
VNIR Sync Time [beginFrame,endFrame,syncTime]	3N	DFNT_INT32	0,223,88 ...
SWIR Sync Time [beginFrame,endFrame,syncTime]	3N	DFNT_INT32	0,223,88
VNIR Time Code [beginFrame, endFrame,TC3,TC4,TC5,TC6, TC7,TC8]	8M	DFNT_INT32	0,224,0,0,0,0,0,0 ...

SWIR Time Code [beginFrame, endFrame,TC3,TC4,TC5,TC6,TC7 ,TC8	8M	DFNT_INT32	0,224,0,0,0,0,0,0
VNIR Channel Offset [A,B,C,D]	4	DFNT_UINT8	5,5,4,5
SWIR Channel Offset [A,B,C,D]	4	DFNT_UINT8	11,11,13,12
SWIR Gain Setting [A,B,C,D]	4	DFNT_UINT8	0,1,1,2
SWIR Integration Time Setting	1	DFNT_UINT8	45

3.2 Level 0 Data Set Transmission

3.2.1 Hyperion Level 0 Electronic Transfer

During early orbit checkout, small scenes, for example, a single cube, will be generated to allow downlink via S-band, with electronic transfer of the data to the MOC. Small scenes can be transferred electronically over the dedicated fractional T-1 link following each DCE (interface S2). Full scenes, downlinked via X-band and transferred to the MOC via tape, can be accessed via Ftp from a DPS server (interface S3) upon special request. Along with this Level 0 data, GSFC (MSO/SVF) will supply metadata (S6) to include the following information: scene request parameters (type of collect, e.g., nadir, pointing, calibration; scene path/row or lat/long; day of year acquired), and an assessment as to the success in meeting these scene request parameters.

This electronic transfer of Hyperion Level 0 science data will be performed over the Internet via the UNIX security shell (ssh). The sequence of events is as follows:

1. The HLZP program will be running on a DPS machine at GSFC.

2. The HLZP program will produce a single Level 0 data file merging the VNIR and SWIR data into a single cube.

3. When the HLZP program has finished generating the file, the file will be transferred via ssh to a HOPC machine at TRW (small files only, during checkout). The account name at TRW for the data transfer will be "hyperion". The data should be placed in the directory /hyperion/L0/.

4. Following checkout, full scenes can be accessed electronically via special request. Upon request by TRW, a copy of the Level 0 data set will be left in an Ftp drop site at GSFC. TRW will pull the file via secure Ftp (ssh), and notify the DPS when the transfer is complete.

3.2.2 AC, ALI, and Hyperion Level 0 Tape Transfer

GSFC will mail to TRW DLT (7000) tapes containing all the Level 0 science data (interface S3) that is generated for Hyperion, AC, and ALI instruments. For the first 60 days on orbit, the tapes will be sent once per day via overnight mail. Level 0 data will be generated and transferred to tape within one working day of data receipt at GSFC. After the first 60 days, the tapes with the Level 0 data will be mailed to TRW via certifed mail twice per week. The tapes should be mailed to:

TRW
R1/1112
One Space Park
Redondo Beach, CA 90278

The filenames for the Hyperion data are described in the HLZP section. The filenames for the AC and ALI data will be described in the appropriate instrument ICD. The format of the tape is documented in Reference 7, Appendix B.

3.3 Level 1 Data Set Transmission

3.3.1 Reserved

3.3.2 AC and ALI Level 1 Data Set Transfer

The SVF will ship data tapes containing ALI and AC Level 1 (radiometrically corrected) data along with available ancillary and metadata files, on an intermittent basis.   The ALI Level 1 data will be in HDF files, TAR format on DLT tapes. Format of ALI data, including ancillary and metadata, is provided in Reference 8. The format of AC Level 0 and Level 1 data is provided in Reference 9.

4. State-of-Health/Housekeeping Interfaces

4.1 S-Band Data

The S-band downlink contains all SOH recorded on the C&DH recorder onboard the spacecraft, the real-time SOH gathered during the contact, and an event log recorded describing anomalous events observed since the previous contact.

4.1.1 Trending Data

Sequential print files (E1), providing a time-ordered listing of parameters converted to engineering units, will be placed on a server at TRW for electronic access.
Table 4-1 lists the Hyperion sensor and cryocooler telemetry parameters that have been selected for trending. The file will provide the selected parameters converted to engineering units over a 24-hour period.

The trended values will be transferred to TRW in files in ASCII format. The files will contain columns that are separated by whitespace ("whitespace" = any number of spaces and/or tabs). The first column will be the "ground receipt time", in units of "seconds since the ASIST epoch", which translates to "seconds since the start of Jan. 1, 1970." The second column is the packet ID number. The third column is the "packet time". For Hyperion parameters, the RDL database will define the "packet time" to be "seconds since the GPS epoch", which translates to "seconds since the start of Jan. 6, 1980." (NB: during the summer of 1999, GPS is scheduled to change the official GPS epoch to some other date, but EO-1 will continue to use the Jan. 6, 1980 date for the "packet time.")

Columns after the third column contain the trended data. The order of these columns is given in Table 4-1.

The data will be transferred by Ftp from GSFC to a TRW server. The filename format is HYPSEQ1yyyydddhhmmss.

Table 4-1 Telemetry Parameters Selected for Trending

Mnemonic	Description
YLAMP1VAL	Cal lamp 1 current
YLAMP2VAL	Cal lamp 2 current
YLAMP1VOL	Cal Lamp 1 Voltage
YLAMP2VOL	Cal Lamp 2 Voltage
YHSATMP5	VNIR ASP temperature
YHSATMP6	SWIR ASP temperature
YVNIRFPET	VNIR FPE temperature
YSWIRFPET	SWIR FPE temperature
YLVDTTEMP	LVDT temperature
YVNRFPGATMP	VNIR FPGA temperature
YHEAP5V	HEA +5V
YHEAP15V	HEA +15V
YHEAN15V	HEA –15V
YCOVERPOS	Cover position
YCRYCOLTM4	Most significant word of timer
YCRYCOLTM5	Least significant word of timer
YCRYCOLTM6	Cryocooler cold head temperature
YCRYCOLTM9	+ Peak drive, side 1
YCRYCOLTM10	- Peak drive, side 1
YCRYCOLTM11	+ Peak drive, side 2
YCRYCOLTM12	- Peak drive, side 2
YPOSOVR1	Position overstroke trip, side 1
YPOSOVR2	Position overstroke trip, side 2
YSHORTSTAT	Short circuit trip
YOVERSTRK	Overstoke state
YACCEL_OVL	Acceleration overload
YWDTRIP	Watchdog trip status
YCOMPTRPLO	Compressor trip (low)
YCOMPTRPHI	Compressor trip (high)
YCLDHDTRIP	Coldhead temperature trip
YNEGOVRST1	Negative overstroke, side 1 trip
YNEGOVRST2	Negative overstroke, side 2 trip
YVIBETRIP	Vibration trip
YCRYCOLTM16	CC electronics temperature 1
YCRYCOLTM7	CC electronics temperature 2
YCRYCOLTM8	CC center plate temperature
YCRYCOLTM22	CC 5V supply
YCRYCOLTM23	CC +12V supply
YCRYCOLTM24	CC –12V supply
YCRYCOLTM25	CC +50V supply
YCRYCOLTM26	CC –50V supply
YCRYCOLTM27	CC 10 Log10 (RSS of all harmonics)
YCRYCOLTM46	CC Motor drive

4.1.2 Recorded Raw Data

The Front End Data System (FEDS) at GSFC will maintain an archive of all EO-1 state-of-health (SOH) data telemetered during the previous six months. This archive will include all state-of-health data for the entire spacecraft and for all three instruments. The archive will be made available for TRW to access on-line using an ASIST workstation located at TRW (E2).

4.1.3 Real-time SOH Data

The ASIST workstation will give TRW the ability to view EO-1 real-time SOH telemetry (VC0, see Table 2-2) as it becomes available to the FEDS (E3). This capability will be used during early orbit checkout to support instrument monitoring and instrument status assessment. The real-time SOH will be available over the dedicated T-1 line between TRW and GSFC (see Figure 2-7).

4.1.4 ASIST Workstation Support

TRW will be using an ASIST Workstation at TRW provided by GSFC for the duration of the EO-1 mission. The ASIST workstation will be set up to format the telemetry for display and to translate SOH/HK telemetry into engineering units. GSFC will create, maintain, and update the user interface for the TRW ASIST.

The Mission Director has responsibility for maintaining the most current version of the software on the TRW ASIST. Updated versions or patches to the existing version are downloaded electronically and then installed by a GSFC representative. Whenever the MOC ASIST software is updated, an identical update will be performed at TRW.

The ASIST workstation will use an IP address for network addressability; the EO-1 network representative is responsible for assigning this address.

4.2 WARP DCE SOH Data

During a DCE, the SOH data collected by the spacecraft is redundantly recorded on the WARP. During playback of the WARP, either via X-band (nominal operations) or via S-band (early orbit checkout, for small scenes), the SOH is downlinked in a separate file by the WARP. This file is processed by the DPS, and selected packets extracted and converted into engineering units by the DPS. This file provides a history of key parameters which describe the onboard environment during the DCE, and is referred throughout this document as “ancillary data” (E4 and E5).

4.2.1 Ancillary Data Contents

The ancillary data extracted from the DCE SOH data will provide the following telemetry parameters converted into engineering units.

Table 4-2 Ancillary Data Contents

APID	Mnemonic	Description
16	PEO1BUSV1	Bus voltage
16	POM2TTLI1	Bus current
17	YCRYFLNGT2	Hyperion cryocooler flange temperature
17	YHEAOMST1	Hyperion OMS temperature
17	YVNIRASPT3	Hyperion VNIR ASP temperature
39	STAT_ACQ	AC sensor mode
59	WHSWRMRC	WARP MV warm restart counter
59	WHSCLDRC	WARP MV cold restart counter
59	WRMWMODE	Current WARP software mode
59	WRMTOTFL	Total number of WARP files
59	WRMFREEBL	Number of free blocks on WARP
59	WRMRECSST	WARP check record status file
59	WRMRECBLKS	Number of WARP blocks recorded
59	WRMSBPST	Current WARP output file, S-band
59	WRMCURLGBLK	Current logical block in WARP S-band playback file
59	WRMXIPBST	Current WARP output S-band I channel
59	WRMXQPBST	Current WARP output S-band Q channel
60	WRMEDACECC	WARP correctable EDAC errors
60	WRMEDACECU	WARP uncorrectable EDAC errors
60	WRMTOTBL	Number of useable blocks on WARP
61	BTLCRSNMOD	Current WARP hardware mode
69	XBNDPWRSTATE	X-band mode
69	XBNDRSNOP	X-band status
69	XBNDPAA5P1V XBNDPAA5P2V XBNDPAA5N1V XBNDPAA5N2V	X-band voltages
69	XBNDPAATEMP XBNDMCMTEMP	X-band temperatures
69	XBNDPAA5P1I XBNDPAA5P2I XBNDPAA5N1I XBNDPAA5N2I	X-band currents
77	YSWIRASPT4	Hyperion SWIR ASP temperature
77	TNADIR1T TNADIR2T TBAY1T	Temperatures
80	ACSBDYXRATS ACSBDYYRATS ACSBDYZRATS	Spacecraft body rates corrected for the KF drift bias
81	ACSKFQ1C ACSKFQ2C ACSKFQ3C ACSKFQ4C	Kalman Filter J2000 inertial to body quaternion
81	ACSPOSERRXC ACSPOSERRYC ACSPOSERRZC	ACS attitude error
81	ACSRATERRXC	ACS rate error

	ACSRATERRYC ACSRATERRZC	
81	ACSSYSMOMXC ACSSYSMOMYC ACSSYSMOMZC	Spacecraft system momentum
82	P052ACSUTCTIME	ACS ephemeris packet UTC seconds since GPS epoch
82	ACSGPSPOSXE ACSGPSPOSYE ACSGPSPOSZE	GPS position propagated to the current ACS cycle time (above)
82	ACSSCPOSXE ACSSCPOSYE ACSSCPOSZE	Spacecraft J2000 inertial position (can be either GPS or ACS)
82	ACSSCVELXE ACSSCVELYE ACSSCVELZE	Spacecraft J2000 inertial velocity (can be either GPS or ACS
82	ACSSCLATE	Spacecraft latitude based on ephemeris above
82	ACSSCLONGE	Spacecraft longitude based on ephemeris above
82	ACSSUNBDYXE ACSSUNBDYYE ACSSUNBDYZE	Sun vector in body based on ACS KF attitude
82	ACSLUNBDYXE ACSLUNBDYYE ACSLUNBDYZE	Moon vector in body based on ACS KF attitude
90	EFFSMODE	Enhanced Formation Flying current mode
90	P05AEFFUTCTIME	EFF UTC time
93	EFFLSXPA11 EFFLSYPA11 EFFLSZPA11	Landsat-7 position from EFF algorithm 1
93	EFFCXPA11 EFFCYPA11 EFFCZPA11	EO-1 position from EFF algorithm 1
93	EFFSVXPA11 EFFSVYPA11 EFFSVZPA11	EO-1 vs. Landsat-7 relative position
123	YSTANDBY	Standby status
123	YDATCOLCT	Data collect status
123	YCOVRSTAT	Commanded cover position status
123	YLAMP1VAL	Calibration lamp 1 commanded value
123	YLAMP2VAL	Calibration lamp 2 commanded value
123	YLAMP1CUR YLAMP2CUR	Hyperion lamp currents
123	YLAMP1VOL YLAMP2VOL	Hyperion lamp voltages
123	YHSATEMP5	VNIR ASP temperature
123	YHSATEMP6	SWIR ASP temperature
123	YCOVERPOS	Hyperion cover position
123	YSWIRFPET	Hyperion SWIR FPE temperature
123	YVNIRFPET	Hyperion VNIR FPE temperature
123	YHEAP5V	Hyperion HEA +5 volts
123	YHEAP15V	Hyperion HEA +15 volts
123	YHEAN15V	Hyperion HEA -15 volts
123	YVNIRP5VD	Hyperion VNIR +5VD

123	YVNIRP5VA	Hyperion VNIR +5VA
123	YVNIRM5VA	Hyperion VNIR -5VA
123	YVNIRP15VA	Hyperion VNIR +15VA
123	YVNIRM15VA	Hyperion VNIR -15VA
123	YSWIRP5VD	Hyperion SWIR +5VD
123	YSWIRP5VA	Hyperion SWIR +5VA
123	YSWIRM5VA	Hyperion SWIR -5VA
123	YSWIRP15V	Hyperion SWIR +15 Volts
123	YSWIRM15V	Hyperion SWIR –15 Volts
123	YCALLMPPWR	Cal lamp power supply voltage
123	YCOMCTR	Hyperion command counter
123	YERRCTR	Hyperion error counter
123	YCRYCOLTM6	Cryocooler coldhead temperature
123	YCRYCOLTM27	Cryocooler 10 Log10 (RSS of all harmonics)
123	YCRYCOLTM46	Cryocooler motor drive
128	IHSKP_DATAGATE	ALI sensor mode or data collect mode

4.2.2 SOH Electronic Transfer

The Data Processing System (DPS) will combine DCE SOH data from all three science instruments on the EO-1 spacecraft into one file. This DCE SOH data file will be transferred from GSFC to TRW electronically (E4) by the UNIX security shell (ssh - allowing TRW fast access to the data).

The DCE SOH data file will be in HDF format. (Format ***TBS*** – Alexander)

The DCE SOH data file will be transferred to TRW via ssh as soon as the data is available (nominally 2 hours after the raw data is received at GSFC). GSFC will use ssh to transfer the data to a TRW processor. The account name at TRW for the data transfer will be "hyperion". The (DCE SOH) data should be placed in the directory /hyperion/transfer/DCE_SOH/.

In addition to the ssh transfer, the same DCE SOH data file will also be transferred via DLT 7000 tape to TRW. The DCE SOH data file will be included on the DLT tape that is sent to TRW with the EO-1 Level 0 science data. (See Section 3.2.2.)

4.2.3 SOH Tape Transfer

The DCE SOH data files (data format and filename format described in the previous section) will be included on the DLT7000 tapes (E5) that are sent to TRW with the EO-1 science data. (See Section 3.2.2.)

4.3 Flight Dynamics Products

TRW requires the flight dynamics products (E6) defined in Table 4-3 from the Flight Dynamics Support Subsystem (FDSS) at the MOC. These products will be produced in Satellite Tool Kit (STK), and delivered in a compressed, comma delimited format. Specific file format details can be found in Reference 10 unless otherwise noted below. They will be available by Ftp on a drop site on a TRW server.

Table 4-3 Flight Dynamics Products

Product	Product Length	Product File Name	File Format
Ascending Node time, Longitude and Orbit No.	8 days, 5 weeks	EO1yyyydoyANODES.S00 EO1yyyydoyANODES.L00	See Reference 10
Descending Node time, Longitude and Orbit No.	8 days, 5 weeks	EO1yyyydoyDNODES.S00 EO1yyyydoyDNODES.L00	See Reference 10
Ground track	8 days, 5 weeks	EO1yyyydoyGRDTRK.S00 EO1yyyydoyGRDTRK.L00	See Reference 10
Station Inviews	8 days, 5 weeks	EO1yyyydoyINVIEW.S00 EO1yyyydoyINVIEW.L00	See Reference 10
X-band Phased Array Antenna Station Inviews	8 days, 5 weeks	EO1yyyydoyINVWXB.S00 EO1yyyydoyINVWXB.L00	See Reference 10
Miscellaneous Zone of Exclusion entry and Exit Times	8 days, 5 weeks	EO1yyyydoyMISZOE.S00 EO1yyyydoyMISZOE.L00	See Reference 10
South Atlantic Anomaly Entry and Exit Times	8 days, 5 weeks	EO1yyyydoySAATIM.S00 EO1yyyydoySAATIM.L00	See Reference 10
EO-1 spacecraft shadows	8 days, 5 weeks	EO1yyyydoySHADOW.S00 EO1yyyydoySHADOW.L00	See Reference 10
EO-1 sub-satellite point shadow entry and exit times	8 days, 5 weeks	EO1yyyydoySUBSHA.S00 EO1yyyydoySUBSHA.L00	See Reference 10
EO-1 Orbit Ephemeris files	8 days, 5 weeks	EO1.8days.Dyymmdd.e EO1.5Weeks.Dyymmdd.e	STK e.file format
Mean local time of ascending	8 days, 5 weeks	EO1yyyydoyMLTAND.S00 EO1yyyydoyMLTAND.L00	See Reference 10
Mean local time of descending node	8 days, 5 weeks	EO1yyyydoyMLTDND.S00 EO1yyyydoyMLTDND.L00	See Reference 10
EO-1 Maneuver Command File	N/A	EO1yyyydoyEO1MCF.vv	See Reference 10
EO-1 Maneuver Planning file	N/A	EO1yyyydoyEO1MPF.vv	See Reference 10
Landsat-7 maneuver planning file	N/A		See Reference 10
Sun angles at WRS scene centers	N/A	EO1yyyydoyWRSSUN.vv	See Reference 10
Lunar calibration slew	N/A	EO1yyyydoyLUNSLW.vv	See Reference 10
Deep space calibration slew	N/A	EO1yyyydoyDSPSLW.vv	See Reference 10
Solar calibration slew	N/A	EO1yyyydoySOLSLW.vv	See Reference 10
Engineering calibration slew	N/A	EO1yyyydoyENGSLW.vv	See Reference 10

5. Planning Interfaces

5.1 Scene Requests

5.1.1 Early Orbit Checkout

TRW will prepare an Early Orbit Checkout plan that will contain a day-by-day list of scene and calibration requests covering the first 60 days of operations. This list will include the primary list as well as a contingency list in the event a high priority scene was not successfully acquired at the originally scheduled time. The list will use the form developed by the Mission Science Office for supplying the necessary information (see Table 5-1).

TRW will prepare a scene request form to cover any changes from the initially submitted Early Orbit Checkout plan. Although the GSFC point-of-contact (POC) has not yet been identified, it is anticipated that the process for requesting new scenes will match the process used by the Mission Science Office during normal operations using the attached scene request form. This interface is represented as P1 in Figure 2-5. The schedule and status of any requested DCE is available to TRW from the EO-1 Project Checkout Team, shown as P3 in the figure.

A draft calibration request form (see Table 5-3) that includes the necessary calibration parameters for Hyperion only is shown below.

TRW will prepare a calibration request form to cover any changes from the initially submitted Early Orbit Checkout plan. Although the GSFC POC has not been identified, it is anticipated that the process for requesting new calibrations will match the process used by the Mission Science Office during normal operations.

5.1.2 Science Validation

TRW will support long term planning (P6) for Hyperion by submitting scene requests to the Coordination Committee. Long term planning uses the same form as will be used for scene requests during science validation operations. During normal operations, TRW will prepare scene request forms (see Table 5-1) for submission to the MSO (interface P2) via e-mail. These requests are part of the twenty percent of total collects during normal operations that are allocated to the instrument teams for instrument maintenance and performance monitoring. The request may be submitted at one of three levels: as a request for a Landsat-like scene using path and row numbers (see Table 5-2), as a scene centerpoint latitude/longitude plus scene duration, or by providing the full list of detailed information called out on the form. The scene requests will be submitted on a weekly basis to serve as input to the Mission Science Office's 5-week planning process. Except in unusual circumstances, scene requests must be submitted not later than 3 weeks in advance of the desired date. The Mission Science Office will develop a weekly "prioritized" scene list of 8-10 targets per day, of which up to 4 targets will be scheduled per day, based on input from all users during the normal operation phase of the program. The Flight Operation Team will interface with the MSO on a daily basis (M-F) to manually select which of the 8-10 potential targets will be scheduled based on priority and cloud cover predicts.

Table 5-1 Draft Scene Request Format

Item	Format	Range
Comment Field (Text field to provide additional information to clarify request. For FOT input only.)	Text	<256 char.
Scene request type (NDR=nadir, PTG=pointing, MTN=maintain, CAL=calibration, STE=stereo, SPC=special,…)	XXX	
Paired Scene Abort (Y=abort if not on L7 target list)	X	Y/N
Acquisition request ID (request unique, >1 scene possible)	(10 Alphanumeric)	

Item	Format	Range
Scene ID (see below)	(21 Alphanumeric)	
Scene path	NNN	1-233
Start row (row 1-123 = day, 124-248 = night)	NNN	1-248
Delta Time Offset from WRS start row (always positive)	+NN	0 – 27
Stop row	NNN	1-248
Delta Time Offset from WRS stop row (NN subtracted from nominal endtime)	NN	0 - 27
Day of year	NNN	1-366
Year	NNNN	≥1999
Sensor mode (which science streams are to be collected) Bit 0 (least significant bit) = MS/Pan Bit 1 = AC1 (30 Hz) Bit 2 = AC2 (60 Hz) Bit 3 = HSI SWIR Bit 4 = HSI VNIR e.g. Hex number '05' (in binary 00000101) means turn on both MS/Pan and AC2	HH (hex)	00-FF
Pointing Mode: X A-E A. baseline nadir: Zero roll angle, with instruments pointing at edge of Landsat swath, plus a roll/pitch/yaw offset. B. instrument roll/pitch/yaw: Use roll/pitch/yaw offset fields to determine pointing of the specified instrument. Values of 0,0,0 indicate that the instrument is pointing straight down. C. instrument at a latitude/longitude: A given instrument is pointing at a particular scene location given by latitude and longitude, plus a roll/pitch/yaw offset. MOPSS will use latitude and longitude to calculate roll angle. D. stereo Landsat: Paired scene (co-view) with Landsat 7. Scene location given by latitude and longitude, pitch is calculated by MOPSS, Path/Row is for L7. E. Maintain pointing attitude of previous scene.	X	A-E
Roll offset (degrees) (using FDSS supplied tool)	+- NNN.NNNNNN	0 to +-360
Pitch offset (degrees) (using FDSS supplied tool)	+- NNN.NNNNNN	0 to +-360
Yaw offset (degrees) (using FDSS supplied tool)	+- NNN.NNNNNN	0 to +-360
Latitude/longitude/sensor (EO-1 MOPSS support field is an enhancement) (i.e., to specify a particular sensor is to point to a particular lat/long) Site latitude (degrees) Site longitude (degrees)	 +-NN.NNNNNN +-NNN.NNNNNN	 0 to +-90 0 to 360
Sensor (1 = MS/Pan, 2 = MS/Pan_1, 3 = MS/Pan_2, 4 = MS/Pan_3, 5 = MS/Pan_4, 6 = AC, …)	NN	1-15
Alignment bias (none, ALI, HSI)	XXXX	
Maximum acceptable cloud cover (in %; abort if predicted cloud cover > threshold; 100=always acquire)	NNN	0-100
Maximum acceptable solar zenith angle (degrees, 99-take in any case)	NNN	0-99
Momentum management priorities HIGH (optimized for image) MARGINAL (try for optimal range but any wheel speed not near zero is OK)	X	(H, M, A, S, N)

Item	Format	Range
ANY (try for optimal range but any wheel speed is OK) SPECIFIED (get optimal range from WHEEL_SPEED parameter) NONE (don't perform momentum management) (FDSS will retrieve appropriate wheel speeds from file for HIGH and MARGINAL mm checking)		
Wheel speed Specific allowable minimum wheel speed for momentum management checks Specific allowable maximum wheel speed for momentum management checks (applied only when SPECIFIED is used for mm)	 NNNN NNNN	
Set ALI Parameters	X	Y/N
ALI Integration time – nominal value or specified value (in microseconds)	NNNN.NNN	0 to <10000
ALI Frame rate	NNNN	0-4095
Acquisition priority (999 is highest priority)	NNN	0-999
Special AC DEEP_SPACE calibration required (if AC is on, the dark Earth is taken within two orbits). Default to N.	X	Y/N
Auto release (whether OPS should confirm ground release prior to releasing data for WARP overwrite. Generally will automatically release prior to next image). Default to Y= release without confirmation.	X	Y/N

Table 5-2 Landsat Scene Request Format

Scene ID: AAABBBCCCDDDDEEEFGHIJ

Field	Item	Data Range
AAA	Satellite	EO1
BBB	Path	001-233
CCC	Row	001-248
DDDD	Year	≥1999
EEE	Day of Year	001-366
F	Hyperion	0=off, 1=on
G	MS/Pan	0=off, 1=on
H	AC	0=off, 1=on (AC1 data rate), 2=on (AC2 data rate)
I	Pointing	N=nadir (ALI, Hyp at ~7^{o}), P=pointed within path/row, K=pointed outside path/row, L=lunar cal, S=Solar cal, D=deep space cal, A=dark earth cal
J	Scene Length	F=full scene, P=partial scene, Q=second partial scene, S=swath

Example: EO10150332000140111NF
would be a nadir acquisition of Washington, D.C., on May 19, 2000 (leap year!), with all three instruments "on".

A draft calibration request form (Table 5-3) that includes the necessary calibration parameters is shown below. TRW will prepare a calibration request form for submission to the MSO via e-mail. The calibration requests will be submitted on a weekly basis to serve as input to the Mission Science Office's 5-week planning process. Except in unusual circumstances, requests must be submitted not later than 2 weeks in advance of the desired date.

Table 5-3 Hyperion Calibration Request Inputs

GENERAL :
- cal type : solar, lunar, internal cal
- Hyperion DCE parameters : duration of collection, nonstandard sequence

SOLAR -
- Scheduling CONSTRAINTS :
  * Specific start / end time
- Slew Rate for Solar Crossing
- Length of Coast before / after sensor in views (#### in degrees)
- Settling time prior to Data Collect Slew (#### secs)
- Settling time prior to Dwell data collects (#### secs)
- Special Ops Reqs - Special instrument config specs
- Solar dwell time (#### secs)

LUNAR -
- Scheduling CONSTRAINTS :
  * Specific start / end time
- Slew Rate for Moon Crossings
- Length of Coast before / after sensor in views (#### in degrees)
- Settling time prior to Data Collect Slew (#### secs)
- Special Ops Reqs - Special instrument config

INTERNAL CAL -
- CONSTRAINTS :
  * Specific start / end time
- DCE duration (#### secs)
- Special Ops Reqs - Special instrument config specs

5.2 DCE Schedule and Status Transmission

5.2.1 Early Orbit Checkout

TRW will develop a detailed Early Orbit Checkout plan in cooperation with the MSO for the EO-1 Project Checkout Team. Once the Checkout plan has been developed, schedule changes that occur for any reason will be tracked using a GSFC web page. TRW will subscribe to the web page notification feature (if available) and receive notices of schedule updates on an as-available basis. TRW will be responsible for accessing the web page and retrieving schedule changes once notified (P3). The format of web page is described in Reference 7.

5.2.2 Science Validation

GSFC will update the DCE acquisition schedule on a daily or as-needed basis. TRW will be responsible for accessing the web page and retrieving schedule changes as needed (P4). The format of web page is described in Reference 7.

6. Acronym List

Acronym	Description
AC	Atmospheric Corrector
AGC	Automatic Gain Control
ALI	Advanced Land Imager
ASIST	Advanced System for Integration and Spacecraft Test
ASP	Analog Signal Processor
BSQ	Band Sequential
C&DH	Command and Data Handling
CGS	Core Ground System
DCE	Data Collection Event
DEC	Digital Equipment Corporation
DLT	Digital Linear Tape
DPS	Data Processing System
EFF	Enhanced Formation flying
EO-1	Earth Observing-1
FDSS	Flight Dynamics Support Subsystem
FEDS	Front-end Data System
FPE	Focal Plane Electronics
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
HDF	Hierarchical Data Format
HEA	Hyperion Electronics Assembly
HK	Housekeeping
HKRSN	Housekeeping Remote Services Node
HLZP	Hyperion Level Zero Processor
HOPC	Hyperion Operations Center
HYP	Hyperion
ICD	Interface Control Document
L&EO	Launch & Early Orbit
LFSA	Lightweight Flexible Solar Array
LL	Lincoln Laboratory
LSB	Least Significant Bit
LTP	Long Term Plan
LVDT	Linear Voltage Differential Transistor
LVPC	Low Voltage Power Converter
MIT	Massachusetts Institute of Technology
MOC	Mission Operations Center
MOPSS	Mission Operations Planning and Scheduling System
MPO	Mission Planning Office

MSB	**Most Significant Bit**
MSO	**Mission Science Office**
MTB	**Magnetic Torque Bars**
NASA	**National Aeronautics and Space Administration**
NCSA	**National Center for Supercomputing Applications**
NRA	**NASA Research Announcement**
POC	**Point of Contact**
PPT	**Pulse Plasma Thruster**
RF	**Radio Frequency**
RSN	**Remote Services Node**
RT	**Real Time**
SAFS	**Standard Automated File Service**
SDS	**Scientific Data Set**
SOH	**State of Health**
SSC	**Stennis Space Center**
STK	**Satellite Tool Kit**
SVF	**Science Validation Facility**
SWIR	**Short Wave Infra-Red**
TAR	**Tape Archive Record**
TBD	**To Be Determined**
TLM	**Telemetry**
VC	**Virtual Channel**
VNIR	**Visible Near Infra-Red**
WARP	**Wideband Advanced Recorder Processor**

7. TBS Table

Item	Description	Document Reference	Assignee	Due Date
TBS	DCE SOH data file format	Section 4.2.2	Alexander	11 June 1999

Date: Fri, 25 Jun 1999 16:29:23 -0400 (Eastern Daylight Time)
From: Administrator <administrator@hst-nic.hst.nasa.gov>
Reply-to: (Thomas Brakke/923)
Subject: CCR:0033 - DUE: 06/25/99 ROUTINE Level-2 Thomas Brakke/92 WWW-COMMENTS

USER : (Thomas Brakke/923) sent the following comments on :

Date: 6/25/99
CCR Number: 0033
Sponsor: D. Mandl
Due Date: 06/25/99

CCR Title: Baseline EO-1 TRW/GSFC INTERFACE DOCUMENT

Remote host: 128.183.109.77 Email Address: tbrakke@ltpmail.gsfc.nasa.gov
----
APPROVAL STATUS: APPROVED WITH COMMENTS
Note:

COMMENTS: A comment on section 2.1.2.3:

DCE Catalog: The MSO will have a database with scene requests and scheduled dates, the SVF will have the acquired-scene database. It is TBD who will create a web page that accesses these databases to provide users (including TRW) with information on scheduled DCEs, their collection status, and the quality of any completed collections.

There is also no mention in the document about TRW providing Level 1 processed Hyperion data to GSFC. This should be mentioned, even if there is some proprietary information that can't be included.